CLAIMS

We claim:

1. A sampling chamber for performing optical measurements on a sample of a flowing fluid comprising:

a flow line for the passage of said fluid;

a recessed cavity in fluid contact with said flow line, and directed in a generally downward direction such that a sample of fluid in said flow line can enter said cavity; and

an optical transmission path passing through said cavity in such a position that it lies outside the confines of said flow line.

2. A sampling chamber according to claim 1 and wherein said optical transmission path comprises an entry port for inputting a light beam from a source, and an exit port for outputting light to a detector.

3. A sampling chamber according to claim 2 and wherein said input port and said output port are disposed such that said light beam traverses said sampling chamber linearly, such that said sampling chamber can perform transmission optical measurements.

4. A sampling chamber according to claim 2 and wherein said output port is disposed at an angle to the direction of said light beam, such that said sampling chamber can perform scattering optical measurements.

5. A sampling chamber according to claim 2 and wherein said exit port is disposed essentially co-positional with said input port such that said sampling chamber can perform back-scattering optical measurements.

6. A sampling chamber according to claim 1 and wherein said recessed cavity is such that said sample is repeatedly changed by the effects of the flow of said fluid in said flow line.

7. A sampling chamber according to claim 1 and wherein said recessed cavity is such that said optical measurements are generally unaffected by turbulence in said flow line.

8. A sampling chamber according to claim 1 and wherein said recessed cavity is such that said optical measurements are generally unaffected by pulsations in said flow line.

9. A sampling chamber according to claim 1, and wherein said fluid is milk.

10. A sampling chamber according to claim 2, and wherein said fluid is milk.

11. A sampling chamber according to claim 1, and wherein said optical measurements are utilized to determine relative concentrations of components of said fluid.

12. A system for determining the concentration of at least one component of a fluid, said fluid comprising at least two components having different optical properties, said system comprising:

a sample chamber containing said fluid;

a plurality of illumination sources, at least one of which, when excited, emits light in an essentially continuum of wavelengths, at least two of said sources having different spectral ranges of emission, said sources being disposed

such that the light from said sources is incident on said fluid in said sample chamber;

a first detector disposed such that it measures the intensity of said light transmitted through said fluid;

a second detector disposed such that it measures the intensity of said light scattered from said fluid;

a control system which serially causes excitation of at least two of said illumination sources, such that said fluid is separately scanned with wavelengths of said light of said at least two illumination sources; and

a computing system operative to determine said concentration of said at least one component of said fluid from said intensity of said light transmitted through said fluid and said light scattered from said fluid.

13. A system according to claim 12, and wherein said sources are light emitting diodes.

14. A system according to claim 13, and wherein the spectral half width of emission of at least one of said light emitting diodes is less than 40 nanometers.

15. A system according to claim 13, and wherein the spectral half width of emission of at least one of said light emitting diodes is less than 60 nanometers.

16. A system according to claim 12, and wherein said plurality of illumination sources is at least five illumination sources.

17. A system according to claim 12, and wherein said plurality of illumination sources is at least ten illumination sources.

18. A system according to claim 12, and wherein said second detector is disposed such that it measures the intensity of light reflected from said fluid.

19. A system according to claim 12 and wherein said computing system is operative to determine said concentration by fitting the intensity of said light transmitted through said fluid and of said light scattered from said fluid to an expression for said concentration in terms of said intensities.

20. A system according to claim 19 and wherein said expression is a polynomial expression of at least second order in said transmitted and scattered intensities.

21. A system according to claim 19 and wherein said transmitted and scattered intensities are related to the concentration of said component by means of empirical coefficients, and wherein said empirical coefficients are determined by a statistical analysis of transmitted and scattered intensities obtained from a plurality of samples of said fluid having known concentrations of said component.

22. The system of claim 21, wherein said statistical analysis is a Partial Least Squares regression method.

23. The system of claim 21, wherein said statistical analysis is a Ridge Least Squares regression method.

24. The system of claim 21 wherein said empirical coefficients are stored in a database, and said concentration is extracted from said transmitted and scattered intensities by means of statistical analysis methods operating on said database.

25. The system of claim 12 wherein said fluid is milk.

26. The system of claim 13 wherein said fluid is milk.

27. The system of claim 25, wherein said system determines the constitution of milk on-line during the milking process.

28. A method of determining the concentrations of at least one component of a fluid, said fluid comprising at least two components having different optical properties, comprising the steps of:

(a) illuminating said fluid with incident light from a source essentially having a continuum of wavelengths of emission; and

(b) measuring on said fluid transmitted and scattered intensities of said incident light; and

(c) fitting said intensities to a polynomial expression for the concentration of said component in terms of said intensities, said polynomial expression being at least second order in said transmitted and scattered intensities.

29. The method of claim 28, wherein said polynomial expression is of third order in said transmitted and scattered intensities.

30. The method of claim 28, wherein said scattered intensities are reflected intensities.

31. The method of claim 28, wherein said source having a continuum of wavelengths is a light emitting diode.

32. The method of claim 31, wherein the spectral half width of said light emitting diode is less than 40 nanometers.

33. The method of claim 31, wherein the spectral half width of said light emitting diode is less than 60 nanometers.

34. The method of claim 28, wherein said transmitted and scattered intensities are related to the concentration of said component by means of empirical coefficients, and wherein said empirical coefficients are determined by a statistical analysis of transmitted and scattered intensities obtained from a plurality of samples of said fluid having known concentrations of said component.

35. The method of claim 34, wherein said statistical analysis is a Partial Least Squares regression method.

36. The method of claim 34, wherein said statistical analysis is a Ridge Least Squares regression method.

37. The method according to claim 28, and also comprising the steps of repeating steps (a) and (b) using a plurality of sources, each source having its own continuum of wavelengths.

38. The method of claim 37, wherein at least one of said plurality of sources is a light emitting diode.

39. The method of claim 37, wherein said empirical coefficients are stored in a database, and said concentration is extracted from said transmitted and scattered intensities by means of statistical analysis methods operating on said database.

40. The method of claim 28, wherein said fluid is milk.

41. The method of claim 31, wherein said fluid is milk.

42. The method of claim 29, wherein said fluid is milk.